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SOME METEOROLOGICAL ASPECTS OF NEBRASKA TORNADOES

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[Department of Geography, University of Nebraska, February 1938]

INTRODUCTION

The tornado, as is well known, has its genesis at the lower cloud level. At a propitious moment the whirling funnel-cloud descends to the ground, raising a mighty cloud of dust and debris. Having run its course on the ground, the lower section of the funnel-cloud may dissolve, while the upper portion continues its travel in mid-air or dies out at the cloud level. Exemplary and illustrative of these phases of a tornado's existence are the accompanying photographs taken at York, Nebr. The funnel-cloud, as shown in figure 1, is descending earthward. In figure 2 it has reached the ground and is attended by a swirling cloud of dust and debris. As shown in figure 3 the funnel-cloud has assumed the appearance of a rising phenomenon due to the dissolution of its lower section; the dust whirl is still existent.

TIME-AREAL DISTRIBUTION

From a study of Nebraska tornadoes as observed and recorded by the United States Weather Bureau and their cooperative observers in Nebraska from 1916–37, it was found that the State experienced 121 tornadoes during the 22-year period.[1] Most of these storms originated within the State. Less than 20 entered from adjoining States, most of them coming from Kansas. These 121 tornadoes were concentrated in the general eastern and southern sections with detailed concentrations in northeastern, southeastern, and south-central Nebraska (fig. 4). The northwestern section of the State experienced the fewest tornadoes, only eight being recorded for the entire Panhandle area. In proportion to size Madison County in the northeast ranked first among the counties of the State in total number of tornadoes experienced.

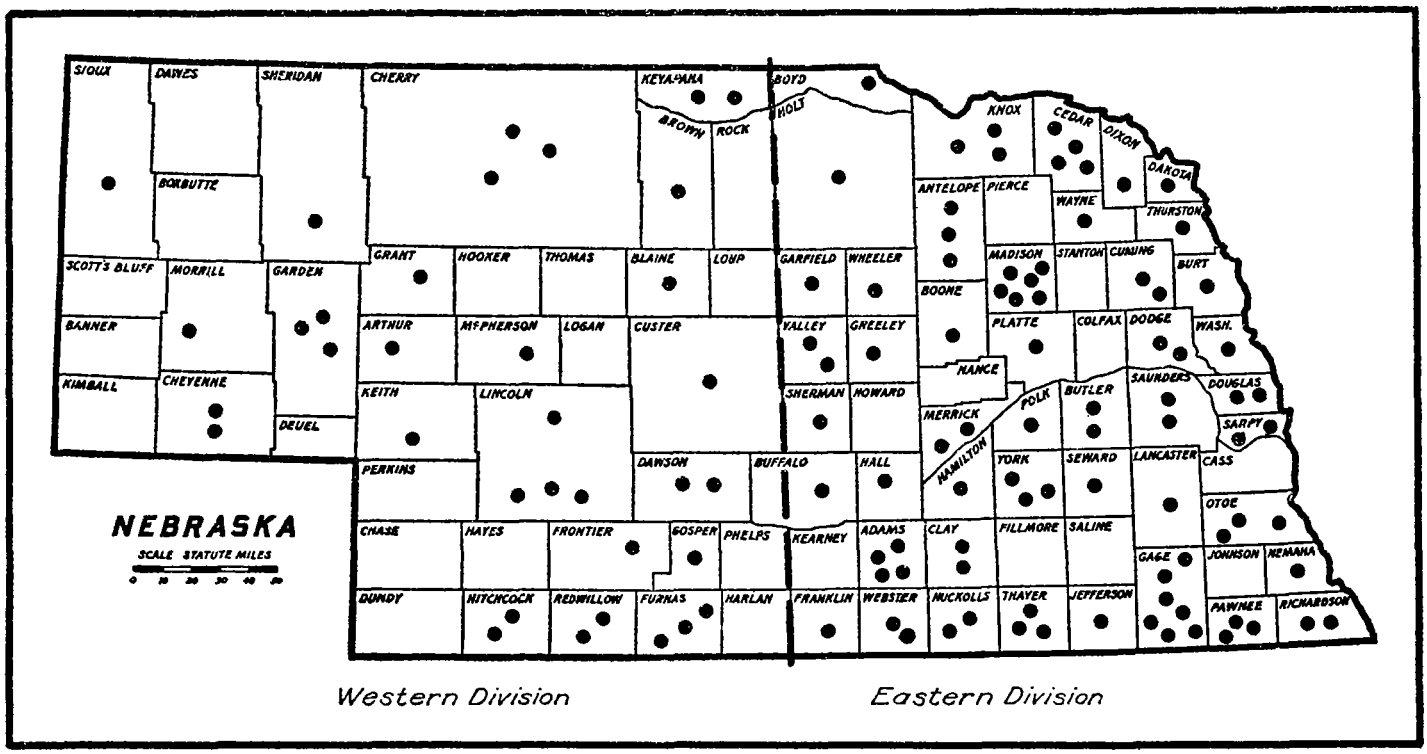

FIGURE 4.—The distribution of tornadoes by counties. Each dot represents a tornado. The dots do not represent the places of origin of the tornadoes.

The average yearly occurrence for the State was 5.5 tornadoes. Imagining a uniform distribution of these over the State, only one tornado would have visited each 14,000 square miles. The actual number of tornadoes per year varied from 1 to 14 (fig. 5). Moreover, the numbers varied widely with consecutive years. In 1930 there were 13 tornadoes; in 1931 the minimum, 1, was recorded.

The tornado "season" consists of spring, summer, and early autumn, lasting through the 7-month period, March

[1] This discussion and the accompanying illustrative graphs and map are based on data secured from the U. S. Weather Bureau Office, Lincoln, Nebr.

Photographs by Wright and Gale, York, Nebr.

FIGURE 1.—Formation of the tornado. The funnel cloud is descending earthward.

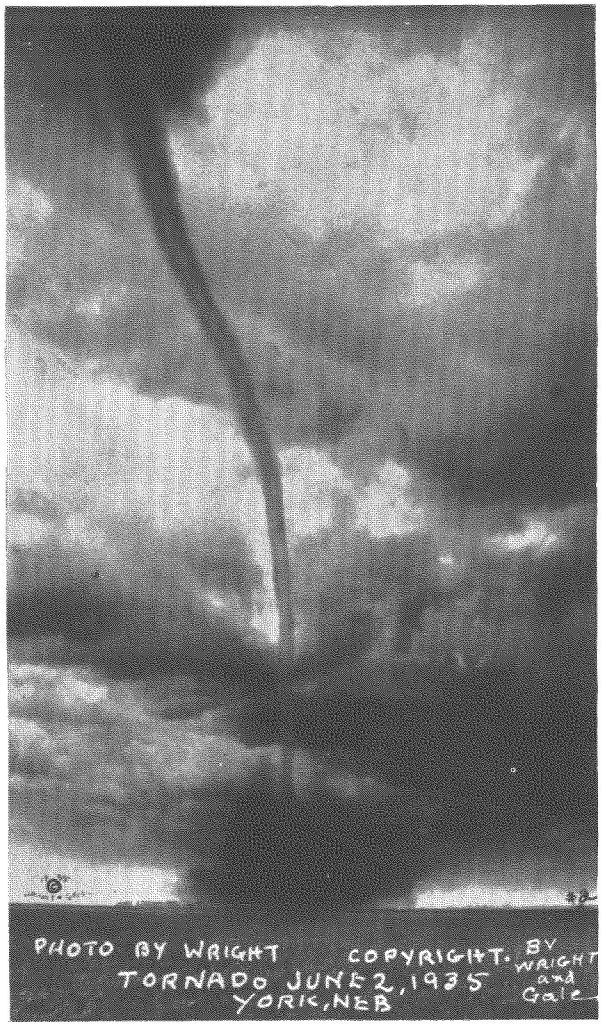

FIGURE 2.—The funnel cloud touching the ground. Note the attendant dust cloud.

FIGURE 3.—The funnel cloud with the appearance of a rising phenomenon due to the dissolution of its lower section; the dust whirl is still existent.

to September (fig. 7). March 14, 1919, was the earliest day of spring having a recorded tornado; while September 28, 1923, was the latest day of autumn with one recorded. No tornadoes occurred in the late autumn and winter months, October to February, inclusive. The curve of monthly tornadic occurrence for the "tornado season" reveals a minimum in March and a maximum in May, followed by a secondary maximum in September (fig. 7). The occurrence of the maximum number in spring rather than in late autumn or winter was fortunate for human life, since many people engaged in out-door

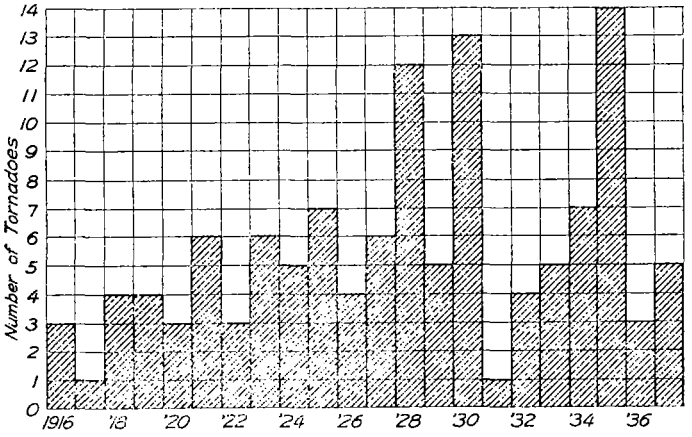

FIGURE 5.—Tornadoes in Nebraska during the 22-year period, 1916–37, inclusive. (121 tornadoes.)

activities at this season had opportunities to see approaching tornadoes and protect themselves. Similarly the afternoon, rather than a night, maximum was fortunate. The greater relative occurrence in eastern Nebraska was unfortunate because of the greater concentration of population and property there.

Nebraska tornadoes were concentrated in the late hours of the afternoon, particularly from 3 p. m. to 8 p. m. Eighty-one percent of the tornadoes occurred during these hours for the period of this study, leaving 19 percent to the remainder of the day. The graph of occurrence by half-hour intervals shows a peak at 4 p. m. (fig. 6). The curve for the afternoon and evening reaches the base line at 11:30 p. m. The afternoon daily maximum for the 24-hour tornadic distribution undoubtedly is related to surface heating and convection, since it approximates the time of occurrence of the daily maximum temperature. However, just how much effect this factor has on tornado inception is unknown at present. It is known that tornadoes originate at the lower cloud level and progress earthward and surface heating and convection may assist the formation of the funnel-cloud in its earthward descent.

The United States Weather Bureau records for Nebraska show that a majority of the storms, 71 percent of those recorded, occurred in the eastern section while only 29 percent occurred in the western (fig. 4). However, as Weather Bureau stations and towns are more numerous, and population is more dense in eastern than in western Nebraska, the chances are that a greater percentage of the tornadoes occurring were seen and reported in the former than in the latter area. Weather Bureau officials rely for much of their tornado information on eyewitnesses and on small-town newspaper reports. Nevertheless, the more logical and generally accepted reason is the location of eastern Nebraska. This section, more so than the western, lies in the paths and meeting places of two types of air masses—the southward-flowing, cold, dense masses from the north, and the northward-moving, warm, moist masses from the Gulf region. The meeting of these air masses provides the necessary meteorological conditions for tornadic inception.

TORNADIC INCEPTION

Daily weather maps for all days on which tornadoes occurred in the 22-year period were examined with the view of determining, if possible, the number of storms which originated at or near surface fronts. Only the tornadoes originating along surface fronts could be ascertained as the daily weather maps are based primarily on surface data. Sixty-eight percent of the storms positively were of the surface cold-front variety, and 27 percent gave strong indications of surface cold-front origin (fig. 7). One percent originated at surface warm-fronts, 3 percent indicated similar places of inception, and for 1 percent no clues existed on the maps as to their places of origin. It is possible that the latter were of the upper cold-front variety. The majority, 95 percent, of Nebraska tornadoes issued from surface cold fronts or inception was indicated there.

Likewise, from examination of daily weather maps it was discovered that 65 percent of the tornadoes originated in the southwestern quadrants of their respective parent lows (fig. 7). In the northeastern quadrants 11 percent originated, and in the northwestern quadrants 3 percent. However, 86 percent of all the tornadoes originated in the southerly quadrants.

TORNADIC PATHS

The paths of all LOWS from which Nebraska tornadoes originated were traced across the State. Of these, 80 percent traveled northeasterly, 11 percent southeasterly, and 9 percent easterly (fig. 7).

The predominant direction of travel of all tornadoes, regardless of places of origin, was northeast (figs. 7 and 8).

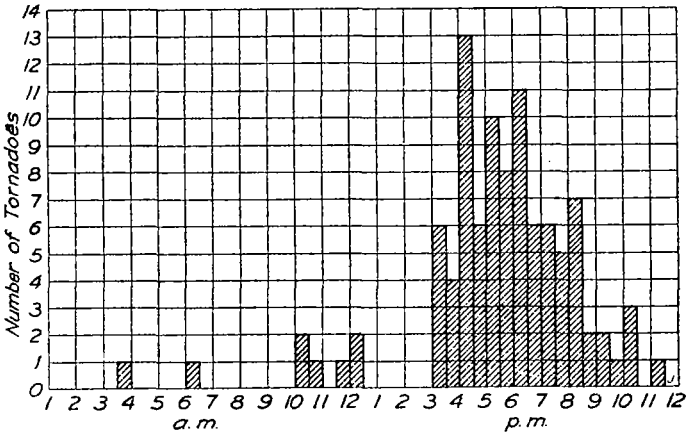

FIGURE 6.—Occurrence of tornadoes by half-hour intervals for the 22-year period, 1916–37, inclusive. (99 tornadoes.)

This accounted for 63 percent. The other 37 percent were divided between northwesterly, northerly, easterly, southeasterly, and southwesterly directions with 16 percent taking the southeasterly course. That tornadoes may follow directions other than general easterly ones is evidenced by those in the present instance which moved north, northwest, or southwest. Tornadic paths in Nebraska for the period studied varied in length from a few yards to 95 miles with a median length of 7.5 miles.

In width they ranged from 16 yards to 1,760 yards with a median width of 288 yards (fig. 8).

RELATIONSHIPS

Certain characteristics of the tornadic origins and travels seemed definitely related to certain features of their parent LOWS. Surface winds of the warm sectors of LOWS move in general easterly and northeasterly directions. An examination of daily weather maps revealed that a majority of Nebraska tornadoes originated in southern quadrants and subsequently traveled northeastward, indicating a relation between the direction of tornadic travel and the direction of the lower winds in the quadrant of origin (fig. 7). Moreover, a relation appeared to exist between the direction of travel of the parent LOW and the direction of travel of the offspring tornado. The examination showed that 63 percent of the tornadoes traveled in northeasterly directions across Nebraska, and that 11 percent of the lows and 16 percent of the tornadoes traveled in southeasterly directions.

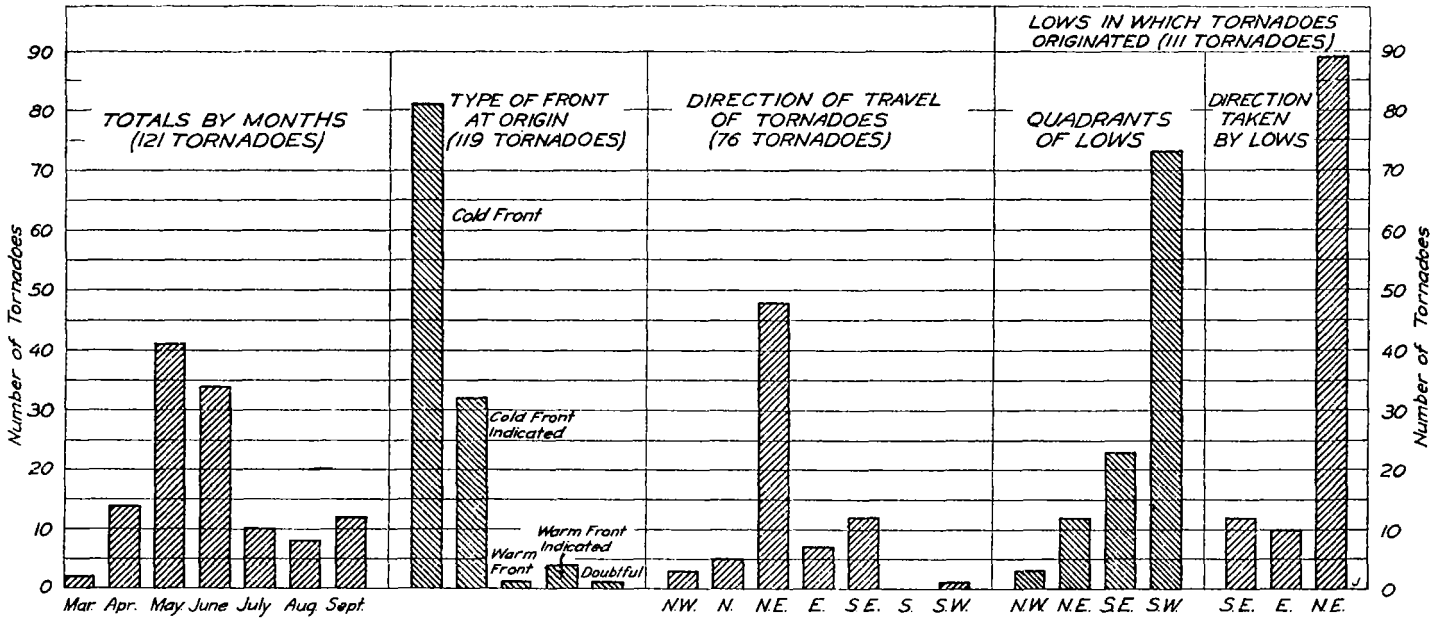

FIGURE 7.—Various classifications of the tornadoes.

THE CHANCE OF ENCOUNTERING A TORNADO IN NEBRASKA

We have seen that for the 22 years comprising the period of this study the average annual number of tornadoes in Nebraska was 5.5, with an average path 7.5 miles in length and 288 yards in width, or an average land coverage of 1.2 square miles each. This makes an average annual land coverage of approximately 7 square miles. There are

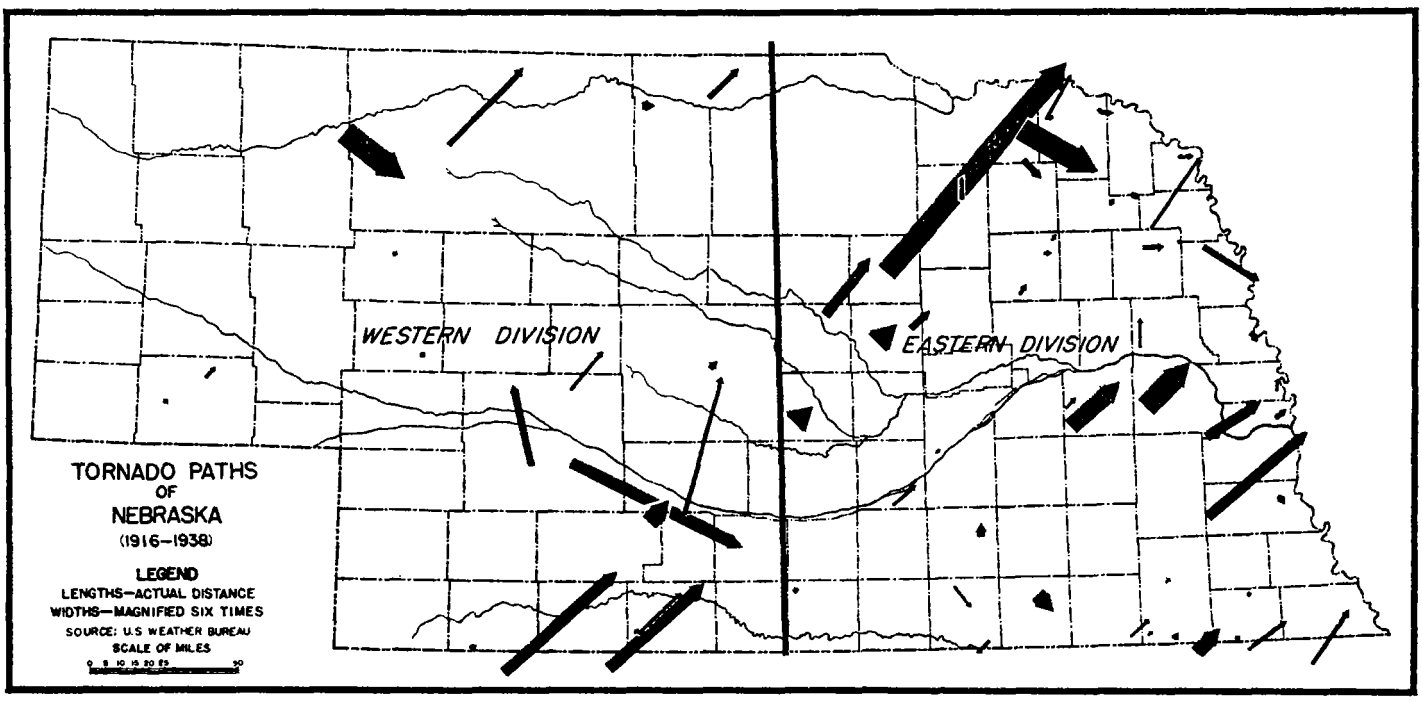

FIGURE 8.

76,808 square miles of land in Nebraska, so that, assuming a uniform areal distribution and that no place would be visited a second time, more than 10,000 years would be required before all localities in the State would experience a tornado. Therefore, the chance of one encountering such a storm in the State, once in more than 10,000 years, is remote indeed. Furthermore, the average annual number of deaths from tornadoes in Nebraska during this period was approximately 1.5. Therefore, as the population of the State is around one and a half million the chance that an individual will lose his life in a tornado is only about one in a million.

A PERIODOGRAM INVESTIGATION OF SHORT-PERIOD SUNSPOT CYCLES

By DINSMORE ALTER

[Griffith Observatory, Los Angeles, Calif., December 1937]

The present report concerns an investigation, the calculations of which were made several years ago and laid aside, because at the time it seemed impossible to make any satisfactory interpretation of quite definite but nevertheless of apparently contradictory results. The remarkable distribution of sunspots during the past year has now thrown a little light upon what may have been happening during the epoch for which this investigation was made, and makes it appear best to publish the results of an extremely long calculation. The data are those gathered by Elsa Frenkel and used by her in 1913.[1] From these data Dr. Frenkel (now Dagobert) computed a Schuster periodogram in an attempt to find short-period solar variations. She did find some evidence of such, especially one of 69.4 days. Her data began with January 1877 and were continued through 1911. She published them as 5-day means of the Wolf relative numbers. On account of the weakness of the Schuster method, it was very difficult to find any definite results.

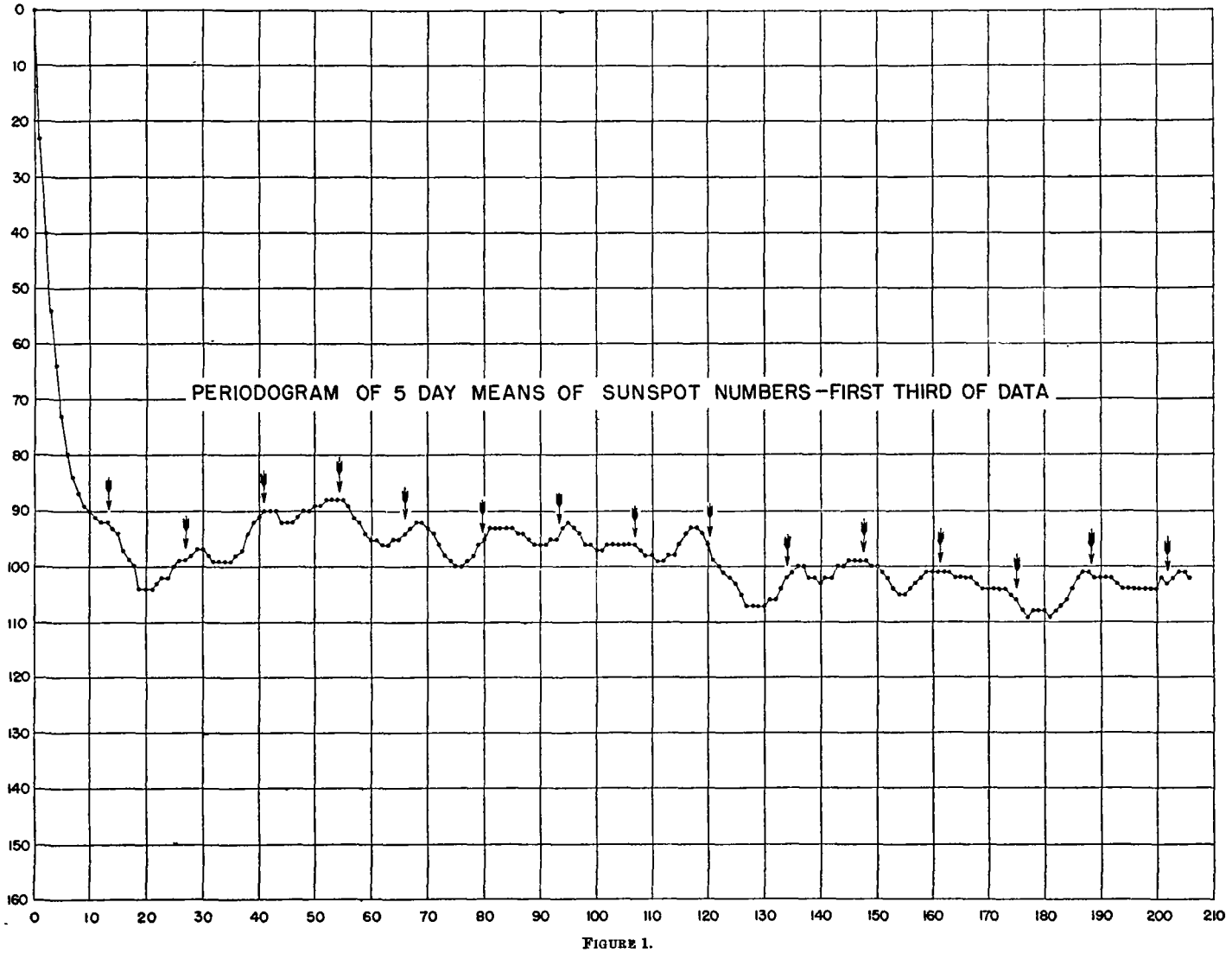

FIGURE 1.

In the present investigation a new form of periodogram of linear type was used.[2] This periodogram uses as an

[1] Frenkel, Elsa. 1913. Untersuchungen über kurzperiodische Schwankungen der Häufigkeit der sonnenflecken. Publikationen der Sternwarte des eidgenössischen Polytechnikums. Band V.

[2] Alter, Dinsmore. 1937. A Simple Form of Periodogram. The Annals of Mathematical Statistics. Vol. 7, No. 2, p. 121.